What is claimed is:

1. A method for cleaning a semiconductor substrate having an etched pattern of lines or trenches thereon or therein, comprising the steps of:

(a) cooling a cleaning solution to a predetermined temperature lower than ambient or room temperature; and

(b) supplying the cooled cleaning solution to the semiconductor substrate to remove etch by-products from the pattern of lines or trenches.

2. The method as defined by claim 1, wherein the cleaning solution comprises hydrofluoric acid (HF).

3. The method as defined by claim 1, wherein the cleaning solution comprises a mixture of deionized water and a member selected from the groups consisting of sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), and hydrofluoric acid (HF).

4. The method as defined by claim 1, wherein the predetermined temperature is a temperature lower than 20℃.

5. The method as defined by claim 4, wherein the predetermined temperature is a temperature of between 0℃ and 20℃.

6. The method as defined by claim 5, wherein the predetermined temperature is a temperature of between 10℃ and 20℃.

7. The method as defined by claim 1, wherein the cleaning step comprises rotating the semiconductor substrate for between several seconds and several minutes, while delivering the cleaning solution to the rotating semiconductor substrate.

8. The method as defined by claim 1, wherein the etched pattern is formed from or in a member selected from the group

consisting of a semiconductor substrate, an insulating layer, a dielectric layer, a conducting layer, and a metal layer.

9. The method as defined by claim 8, wherein the etched pattern comprises a single layer of material.

10. The method as defined by claim 8, wherein the etched pattern comprises a multi-layer structure.

11. The method as defined by claim 8, wherein the etched pattern comprises a conductor selected from the group consisting of aluminum, an aluminum alloy, copper, a copper alloy, a metal silicide layer, and a barrier metal layer.

12. A method for cleaning a semiconductor substrate having an etched metal pattern thereon, comprising the steps of:

(a) cooling an aqueous cleaning solution to a predetermined temperature lower than ambient or room temperature; and

(b) cleaning the semiconductor substrate with the aqueous cleaning solution.

13. The method as defined by claim 12, wherein the aqueous cleaning solution comprises a mixture of deionized water and a member selected from the groups consisting of sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), and hydrofluoric acid (HF).

14. The method as defined by claim 13, wherein the predetermined temperature is a temperature of between 0℃ and 20℃.

15. The method as defined by claim 14, wherein the predetermined temperature is a temperature of between 10℃ and 20℃.

16. The method as defined by claim 12, wherein the etched pattern comprises a single layer of material.

17. The method as defined by claim 12, wherein the etched pattern comprises a multi-layer structure.

18. The method as defined by claim 12, wherein the etched metal pattern comprises a conductor selected from the group consisting of aluminum, an aluminum alloy, copper, a copper alloy, tungsten, a metal silicide layer, and a barrier metal layer.

19. An apparatus for cleaning a semiconductor substrate, comprising:

(a) a chuck on which a semiconductor substrate having an etched pattern is mounted;

(b) a solution storage part for storing a cleaning solution;

(c) a solution supply part for supplying the cleaning solution to the semiconductor substrate;

(d) a heat exchange part for maintaining the cleaning solution at a temperature lower than ambient or room temperature; and

(e) a control part for controlling (i) the chuck so that said chuck rotates for a predetermined time and (ii) said solution supply part and said heat exchange part so that the cleaning solution supplied from the solution supply part to the semiconductor substrate is cooled by the heat exchange part.

20. The apparatus as defined by claim 19, wherein the heat exchange part comprises:

(a) a first valve installed on the solution supply part;

(b) a circulation line having one end connected to the solution storage part and the other end connected to the solution supply part between the first valve and the solution storage part;

(c) a second valve installed on the circulation line; and

(d) a cooling part installed on the circulation line for lowering a temperature of the cleaning solution inside the circulation line.

21. The apparatus as defined by claim 20, wherein the cooling part comprises:

(a) a cooling pipe configured to exchange heat with the circulation line, the cooling pipe having a refrigerant therein; and

(b) a cooler for compressing, expanding, vaporizing, and condensing the refrigerant in the cooling pipe.

22. The apparatus as defined by claim 19, wherein the heat exchange part further comprises:

(a) a heater for raising a temperature of the cleaning solution inside the circulation line; and

(b) a temperature sensing part for measuring the temperature of the cleaning solution inside the circulation line.

23. The apparatus as defined by claim 19, wherein the control part controls (i) the chuck so that said chuck rotates for a sufficient time to remove etch by-products on the semiconductor substrate, (ii) the first valve and the second valve to maintain the cleaning solution in the solution storage part at said temperature and/or to supply the cleaning solution to the semiconductor substrate through the solution supply part.

24. The apparatus as defined by claim 22, further comprising a temperature sensing part in communication with the control part, wherein said control part is configured to control the heater or the cooling part to maintain the cleaning solution at the temperature.

25. The apparatus as defined by claim 19, wherein the predetermined temperature is a temperature lower than 20℃.